AN

INTRODUCTION

TO THE

STUDY

OF THE

ANIMAL ECONOMY;

TRANSLATED FROM THE FRENCH OF

CUVIER,

By JOHN ALLEN,

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AND LECTURER ON THE ANIMAL ECONOMY,
AT EDINBURGH.

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TO THE GENTLEMEN

ATTENDING HIS LECTURES ON THE

ANIMAL ECONOMY,

THE FOLLOWING TRANSLATION,

UNDERTAKEN FOR THEIR USE,

IS,

WITH SINCERE WISHES FOR THEIR WELFARE,

INSCRIBED BY

The TRANSLATOR.

ADVERTISEMENT.

THE following obſervations, on the Animal Economy, are extracted from the introduction to a work, publiſhed about eighteen months ago at Paris, under the title of *Leçons d' Anatomie comparée de G. Cuvier*. As they appeared to the Tranſlator to convey a more correct idea of the eſſential attributes of life, and to afford a more comprehenſive view of the relations that ſubſiſt between the different functions of the Animal Economy, than any work which he had ſeen, he was induced, for the reaſon mentioned in the Dedication, to attempt the tranſlation of them into Engliſh. He has annexed a very few Notes to the laſt chapter, for the ſake of thoſe who might wiſh to compare the arrangement of *Cuvier* with that of *Linnæus ;* but, as the tranſlation was intended for the uſe of Students of Phyſiology, and not for Naturaliſts, he has ſuppreſſed the ſubordinate diviſions of *Cuvier*, and omitted entirely the tables of genera which are annexed to the original work.

The Tranſlator has to apologiſe for ſeveral Galliciſms and other inaccuracies, which, from the haſte with which the tranſlation was originally executed, had inſinuated themſelves into his verſion, and which eſcaped him while correcting it for the preſs. Some of theſe inaccuracies which appeared to alter or obſcure the meaning, he has endeavoured to correct in the table of Corrigenda, placed at the end.

INTRODUCTION

INTRODUCTION

TO THE STUDY OF THE

ANIMAL ECONOMY.

CHAP. I.

A General View of the functions exercised by Animals.

THE idea of *Life* is one of those vague and obscure ideas suggested to us by the observation of phenomena that succeed in regular and corresponding trains. Though unable to discover the nature of the relation between these trains of phenomena, we are satisfied of its existence; and this is sufficient for us to class them together, and distinguish them by an appropriate term, which the vulgar mistake for the name of a particular Agent or Principle; whereas, it is merely a general expression for the phenomena, that suggested the formation of the term.

Thus, having observed in our own bodies, and in many bodies analogous to our own in form and structure, a power of resisting, for a certain period, the laws which regulate

unorganized

unorganized bodies, and even of acting upon other bodies in oppofition to thefe laws, we employ the terms *Life*, *Vitality*, *Vital power*, to exprefs thefe apparent exceptions from the ordinary courfe of Nature. To affix an exact meaning to the terms *Life*, *Vitality*, and *Vital power*, we muft, therefore, determine exactly in what thefe exceptions confift. Let us for that purpofe confider the bodies in queftion, in their active and paffive relations to the reft of Nature.

Take for an example, the Female form, in the fulnefs of youth and health; obferve that rounded and voluptuous fwell of the limbs; that graceful eafe in motion; that balmy warmth; thofe cheeks tinged with the rofes of health; thofe eyes beaming with love, or fparkling with intelligence; that countenance enlivened by wit, or animated by feeling; every thing combined to form an object of fafcination. A fingle inftant fuffices to difpel the charm: often, without an apparent caufe, fenfation and motion ceafe at once; the body lofes its warmth; the mufcles become flaccid, and difclofe the prominent angles of the bones; the eyes lofe their luftre; the lips and cheeks become livid. Thefe are but the preludes to changes more hideous. The colour paffes fucceffively to a blue, a green, a black; the flefh abforbs moifture; and while one part of it efcapes in peftilential exhalations, the remaining part falls down into a putrid, liquid mafs. In a fhort time no part of the body remains, but a few earthy and faline principles; its other elements being difperfed through air, or carried off by water, to form new combinations.

This decompofition of the body after death is the natural effect of the air, moifture, heat, and other external powers; and is occafioned by the chemical affinities of thefe agents for the elementary or conftituent parts of the body. Yet, the body when alive had been furrounded by the fame external agents, which had exerted upon it the fame affinities; fo that a fimilar decompofition muft have taken place during its living ftate, if the elements compofing it had not been kept together by a fuperior force, that ceafed to act upon them at the inftant of death.

Of all the phenomena included in the general idea of Life, this then, is one which appears at firft fight the moft effential to it; fince it is inconceivable, that a living body fhould continue to exift, without the means of refifting decompofition; and in fact, we obferve this preferving power exerted without interuption to the very inftant of death.

But farther attention to the economy of living bodies foon difcovers to us, that the power,

power, which keeps together their elementary parts, in oppoſition to the external forces that tend to decompoſe them, is not confined to this negative operation, but extends its activity beyond the boundaries of the living body. There is at leaſt no reaſon for ſuppoſing any difference between this preſerving power, and that which attracts particles extrinſic to the living body, and interpoſes them between its integrant parts; nor is the action by which foreign particles are introduced into the living body leſs uninterrupted than that by which its own particles are apparently kept together. For, not only is the abſorption of alimentary matter, and its ſubſequent paſſage into the nutritive fluid, and its conveyance by the nutritive fluid to the different parts of the body, carried on with hardly any interruption, from one meal to another; but there is a continual abſorption from the ſurface of the body, and a third kind of abſorption equally conſtant, depending on reſpiration. Theſe two laſt are indeed the only kinds of abſorption, in living beings, which are without organs of digeſtion; that is, in plants.

But, ſince the growth of living bodies is not indefinitely great, Nature having aſſigned to them limits which they cannot exceed, they muſt neceſſarily loſe on the one hand a great part at leaſt of what they receive upon the other; and in fact obſervation has ſhown, that perſpiration and a variety of other means are continually

continually abſtracting from them a part of their ſubſtance.

This conſideration leads us to modify our original idea, with reſpect to the nature of that power, by which living bodies are preſerved from decompoſition. Inſtead of an uninterrupted union in the ſame particles of living matter, we diſcover a continual circulation proceeding without interruption, and yet fixed down within certain limits. In this view of living bodies they may be compared to ſo many eddies or whirlpools, into which inanimate materials are continually drawn; where they are combined together in various forms, detained for a certain time, and applied to different uſes; but from which they are at laſt thrown out, and reſtored to the laws of unorganized matter.

It is neceſſary to add, that the proportion between the quantity of matter paſſing into this current and the quantity diſcharged from it, is liable to variations depending upon age and health; and that the general velocity of the circulation varies according to the nature and condition of every living being.

It appears alſo, that life as naturally terminates in death, as other kinds of motion in reſt; and that the gradual induration of the living fibres, and obſtruction of the living veſſels, would render death the neceſſary conſequence of life, though

it

it were not accelerated by a multitude of accidental caufes.

This general and common motion in all the parts of a living body is fo much the effential attribute of life, that parts, feparated from the body, die fpeedily, becaufe they contain not within themfelves any principle of motion, and only participate in the general motion which is produced by their union into an organized whole; fo that, to ufe the language of Kant, it depends on the living body as a whole, what mode of exiftence fhall belong to its different parts; whereas, among unorganized bodies, the mode of exiftence of every part depends folely upon itfelf.

This effential attribute of life having been once deduced from the conftancy of its effects, it is natural to inquire into its origin, and how it is communicated to the bodies which it animates. For this purpofe Philofophers have gone back to the infancy of living bodies, and endeavoured to trace them as near as poffible to the firft inftant of their formation: but living bodies are hid from our infpection, till formed, in the exercife of life, and in the midft of that vortex of which we feek to difcover the origin. However fmall the parts of an embryo or of a feed, when firft vifible to us, they are already in full poffeffion of life, and contain already the

germ

germ of all the phenomena, which through the means of life they are afterwards to develope. Such inquiries, having in every claſs of living bodies had the ſame reſult, lead to this general concluſion, that, there is no living body, which was not at one time part of another living body, from which it has been ſince detached; that, every living body has participated in the life of another living body, before it was capable of carrying on living motion by itſelf; and, that from the living power of the body to which it originally belonged, it derived that degree of developement, which rendered it ſuſceptible of independent life. The vital motions of living bodies have, therefore, their real origin in the parent ſtock. It is from the Parent that the Offspring receive the vital impulſe; life ſprings from life only; nor is there an example of living power, which has not been tranſmitted from one living body to another, in uninterrupted ſucceſſion.

Since we are, then, unable to trace life back to its origin, we have no other means of aſcertaining the real nature of the living powers, but by examining the ſtructure and compoſition of living bodies, for though it be true that theſe are in ſome meaſure the effects of the living powers, which formed and which ſupport them, ſtill it is equally clear that the living powers can have no other ſource or foundation but in the

the body in which they inhere. If the chemical and mechanical elements of the body were originally combined by the living power of its parent, there muſt be the ſame living power in the body itſelf, ſince it exerciſes a ſimilar action in favour of its deſcendants.

But, our knowledge of the ſtructure and compoſition of living bodies is too imperfect to enable us to explain from it their functions. We ſee, in general, that they are made up of fibres or laminæ, ſo as to form a ſeries of network, more or leſs cloſe, and conſtituting the baſis of all the ſolids, as well of thoſe which have a ſenſible degree of thickneſs, as of thoſe which are mere membranes or filaments. We are acquainted with the figure, conſistence, and poſition of ſuch of the ſolids as have any ſenſible magnitude; we can follow out the more conſiderable ramifications of the veſſels, and know the courſe of the fluids which they convey; but the more delicate branches of the veſsels, and the intimate texture of the ſolids are too fine for our inſtruments. In the ſame manner we have a general acquaintance with the more prominent chemical characters of both the ſolids and fluids; we can decompoſe them to a certain point; yet, not only is this analyſis imperfect, ſince we cannot recompoſe them; but there are phenomena which indicate the preſence of ſubtile matters in living animals, which we have we have not yet been able to bring under our examination.

In the mean time though Philofophers have not been fuccefsful in their endeavours to connect the phenomena of life with the general laws of matter, it would be rafh to infer that they are of a different kind; and, on the other hand, it would be fruitlefs to renew the attempt, while our knowledge of living bodies remains fo limited. We muft, therefore, content ourfelves at prefent, with an empirical in place of a fyftematic expofition of the functions of life, and confine our labours on the economy of organized beings to a delineation of the phenomena.

But, though our knowledge of the compofition of living bodies be infufficient to explain the phenomena which they exhibit, it will, at leaft, enable us to recognife them when not in action, and to diftinguifh their remains long after their death. For no unorganized body prefents us with that fibrous or cellular texture, nor with that multitude of volatile elements which continue to be the characteriftic marks of organized bodies after their vital powers have ceafed.

For example, unorganized bodies are compofed of polyhedral particles, which attract one another by their furfaces, and preferve their refpective diftances unchanged, unlefs feparated by ſome extrinſic force; while organized bodies are conſtructed of flexible fibres or laminæ, incloſing ſpaces filled with a fluid. Unorganized bodies are reſolvable into a ſmall number of fixed ſubſtances, which our inſtruments are unable farther to decompoſe, while organized bodies are reſolved almoſt entirely into elaſtic fluids. Unorganized bodies are produced by the chemical union of their elements, and by the ſubſequent aggregation of the particles of the compound; while organized bodies derive their origin from bodies ſimilar to themſelves, to which they were at firſt attached, and from which, when ſufficiently developed to ſupport themſelves, they were afterwards ſeparated. Unorganized bodies increaſe by the juxta poſition of new particles, which, forming layers, invelope the previouſly exiſting maſs; while organized bodies are continually aſſimilating foreign materials by intus-ſuſception, and thus grow by an internal force. Laſtly, unorganized bodies are not liable to deſtruction, unleſs by ſome mechanical agent that ſeparates their particles, or by ſome chemical power that alters their compoſition; while organized bodies periſh from an internal cauſe, death being a neceſſary conſequence of life.

An origin by *generation*, an increaſe by *nutrition*, a termination by *death*, are then the general and common characteriſtics of all organized beings.

Many

Many organized bodies exercise no functions, but those subservient to the general functions of nutrition and generation; and possess no organs, but those required for the exercise of these functions. But in a great number of organized bodies, there are functions carried on of a subordinate nature, which not only demand appropriate organs, but which influence the economy of these general functions, and modify the structure of the organs by which they are exercised.

Of these subordinate functions, which imply organization, but are not the necessary consequence of its existence, the faculties of sensation and of voluntary motion are the most important, and have the greatest influence upon the economy of the other functions.

We are conscious that these faculties belong to ourselves, and, judging from analogy and from external appearances, we attribute them to a great number of other beings, whom, on that account, we call *animated* Beings, or in a single word *Animals*.

There seems to be a necessary connection between these two faculties. In the first place, the very idea of voluntary motion implies sensibility; for, it is impossible to conceive volition without desire, or without the sensation of pleaſure and of pain. It is true, that ſome inanimate bodies perform very conſpicuous motions proceeding from an internal principle; but theſe motions are of the ſame nature with thoſe which carry on the eſſential functions of Life, and deſerve not the name of voluntary.

In the ſecond place, the benevolence of Nature, ſo conſpicuous in all her works, forbids us to believe it poſſible, that ſhe could have conſtructed ſentient beings, ſuſceptible of pleaſure and of pain, without imparting to them the ſmalleſt power of purſuing the one, or of flying from the other.

But, independently of the neceſſary connection between ſenſation and voluntary motion, and the double apparatus of organs required for exercifing theſe faculties, they lead to ſeveral important modifications in the functions common to all organized beings. In theſe modifications, and in the two faculties themſelves of ſenſation and voluntary motion, conſiſt the peculiarities of animal life.

To take nutrition as an example; vegetables, which are attached to the ſoil, abſorb, by their roots, the nutritive particles of the fluids that moiſten the earth. The minute ſubdiviſions of the roots penetrate into the ſmalleſt intervals of the

the clod, and go in ſearch of nouriſhment for the plant to which they belong. Their action is tranquil, continual, and interrupted only by ths dryneſs of the ſoil.

Animals, on the contrary, having no attachment to the ſoil, but poſſeſſing the locomotive faculty, require to poſſeſs the means of tranſporting along with themſelves the proviſion of juices neceſſary for their ſupport. Accordingly, an internal cavity is given to them, within which they depoſit ſubſtances proper for their nouriſhment, and in the coats of which are placed abſorbing orifices, or, as they are called in the expreſſive language of Boerhaave, the *internal roots* of the animal. The magnitude of this cavity, and the width of the paſſages leading to it, admit, in many animals, the introduction of ſolid ſubſtances. Inſtruments then become neceſſary for the diviſion, and liquids for the ſolution of aliment. The beginning of nutrition ceaſes to be the mere abſorption of fluid matter from the ſoil or atmoſphere. It muſt be preceded by a number of preparatory operations, which, taken together, form what is called *Digeſtion.*

Digeſtion is then a function of a ſecondary order, and, together with the alimentary canal within which it is carried on, peculiar to animals; but though a neceſſary ſequel to the locomotive faculty

faculty of animals, it is not the only conſequence to which that faculty leads.

Vegetables being limited to a ſmall number of faculties, require a very ſimple organization. They are conſtructed almoſt entirely of parallel or ſlightly diverging fibres. The fixedneſs of their poſition renders external agents ſufficient to preſerve in motion the fluid by which they are nouriſhed. Accordingly it aſcends from the roots to their branches, by the attraction of their ſpongy and capillary texture, and by the evaporation from their ſummits; its aſcent is more rapid as the evaporation is increaſed, and its motion becomes even retrograde, when, from the coldneſs or humidity of the air, the evaporation ceaſes, or is ſucceeded by abſorption.

Animals, being deſtined for a continual change of place, and fitted to exiſt in every ſituation and every climate, require within themſelves an active principle, to communicate motion to the fluids by which they are nouriſhed. Becauſe the faculties of Animals are more numerous and more varied than thoſe of vegetables, they require a more complicated ſyſtem of organization, and conſequently poſſeſs a greater variety of parts, more complex in their forms, more diverſified in the arrangement of their fibres, and ſuſceptible of far greater latitude of motion. To convey the nutritive fluid into ſo many winding paſſages as

this

this conformation implies, demands a more confiderable force and a lefs fimple mechanifm than that which fuffices for vegetables.

Accordingly, in the greater number of Animals, we find the nutritive fluid contained within innumerable canals, branching from two principal trunks, the communication of which is fuch, that the one, after receiving into its roots or beginnings, the fluid which the other had carried forward into its branches, brings back this fluid to the centre of the body, from which it is again fent to the extremities.

At the place where the two large trunks communicate, the heart is fituated, which, by an exertion of its contractile power, expels from its cavities the nutritive fluid, and drives it forward into the arteries ; for, there are two valves placed at the two orifices of the heart, which confine the motion of the fluid in the vafcular fyftem to one particular direction ; that is, in the direction from the heart to the extremities by the arteries, and in the direction from the extremities back to the heart by the veins.

This motion, in a circle, is called the Circulation of the blood, and is another function of a fecondary order peculiar to animals, regulated and principally fupported by the heart. But, the circulation is lefs infeparably connected with fenſenſation and voluntary motion than digeſtion is; for, two numerous claſſes of animals are entirely deſtitute of circulation, and nouriſhed, in a manner ſomewhat like vegetables, by the tranſudation of the fluid which is prepared in their alimentary canal. †

In animals where a circulation is found, the circulating blood appears to be a mere vehicle of nutritive particles, receiving continually from the alimentary canal, from the ſurface of the body, and from the lungs, various ſubſtances which it incorporates in the moſt intimate manner, and by which it replaces thoſe particles which it had furniſhed to the different parts of the body for their nouriſhment and growth. It is in the paſſage of the blood through the extreme branches of the arteries, that it contributes directly to the nouriſhment of the ſolids, and where at the ſame time it changes its nature and its colour; nor is it till after the addition of the ſubſtances which have juſt been mentioned, that the blood recovers its power of nouriſhing the ſolids and is reconverted into arterial blood.

A particular ſet of veſſels, called the Abſorbents, convey to the venous blood thoſe ſubſtances which it receives from the ſkin and from the alimentary canal; and the ſame veſſels bring back to it what remains of the ſecretions after

† The claſs of Inſects and the claſs of Zoophytes.

after performing their office, as well as the particles which are ſeparated from the ſolids, in order to be conveyed out of the body by the different emunctories.

With regard to the pulmonary ſyſtem, the air which penetrates into the cavity of the lungs, maintains in the venous blood a ſpecies of combuſtion, which appears to be eſſentially neceſſary to the life of organized beings; ſince it takes place, though by different means in all. Vegetables, and animals deſtitute of circulation, reſpire by the whole of their external ſurface, or by particular veſſels that convey air into the different parts of their interior. But, animals which have a true circulation, are enabled to reſpire by a particular organ; for, the blood flowing continually to and from the heart, can be confined in veſſels, arranged in ſuch a manner that the blood in its way from the heart to the extremities, ſhall neceſſarily paſs through the lungs. This arrangement is obviouſly impracticable in animals, where the nutritive fluid is diffuſed every where in a uniform manner, and not contained in veſſels.

Thus, reſpiration by lungs or gills is a function of a third order; for its exiſtence depends on that of the circulation. It is at the ſame time a remote conſequence of the faculties that characteriſe animal life.

The mode of generation too, in animals, is regulated by their peculiar functions, at least in so far as relates to the fecundation of germs. Possessing sensibility and the locomotive faculty, animals are distinguished from vegetables by their capacity for the enjoyments of love; and with respect to the mechanism of impregnation, their spermatic fluid can be directly applied to the germs; whereas, in vegetables, which are without the means of darting this fluid into its proper receptacle, it is necessary to inclose the pollen in small capsules, within which it may be transported safely by the winds. Thus, while the peculiar functions of animals have procured for them a more complicated apparatus for the greater part of their functions, they allow generation to be exercised by animals in a more simple manner than by vegetables.

These examples will serve to illustrate how much the two faculties of sensation and voluntary motion, peculiar to animals, influence their structure and economy, even in those functions which are common to them with vegetables. It will afterwards appear, when we compare together the different orders of animals, that any modification of one of the principal functions has a similar influence on all the collateral functions: so great is the mutual agreement and harmony between the different parts of a living body.

Such

Such are the principal functions of the animal economy. It is obvious that they may be reduced under three different orders.

The first will consist of the functions which are essential to animal life, which qualify animals to fulfil the part assigned to them by nature in the general arrangement of the Universe, and which would suffice for their existence, if their existence were to be of only momentary duration. To this class belong the faculties of sensation and of voluntary motion. The one enables animals to perform certain actions, and the other determines them to the particular actions which they perform. Every animal may be considered as a particular machine, having certain fixed relations to all the other machines, that together form the Universe. The immediate organs of motion are the pulleys, the levers, the passive parts of this machine; but, the active principle, the spring which gives impulse to the whole, resides in the sensitive principle, without which the animal, sunk in perpetual sleep, would be degraded to the condition of a vegetable; or a vegetable may be called in the language of Buffon, a sleeping animal. Sensation and voluntary motion form then the first order of functions, and are termed the *animal functions*.

But,

But, animated machines differ from thoſe of human contrivance, in poſſeſſing an internal principle of ſupport and reparation; and to this principle are ſubſervient all the functions which contribute to the nouriſhment of the body; that is, digeſtion, abſorption, circulation, reſpiration, perſpiration, and excretion. Theſe functions form together the ſecond order, or the *vital* functions.

In the laſt place, the life of animals having fixed limits, that vary according to the ſpecies, *generation* is a function of a third order, deſtined to ſupply new individuals in the place of thoſe who are removed by death, and thus to perpetuate the exiſtence of every ſpecies of animals.

After theſe general reflections on the functions of animals, and on their mutual relations to one another, we ſhall proceed to conſider the organs by which they are carried on.

CHAP. II.

General idea of the ORGANS *which compose the body of an* ANIMAL.

NO part of an animal body consists entirely of solid particles. Every part affords fluids by expression or exsiccation; and every part has a reticulated texture, like network.

The mechanical division of the body, when carried to its greatest extent, conducts us to small laminæ or filaments, which seem to be the elementary basis of the solids. When these small laminæ are separated from one another, and inclose a sensible space, they form what is called the cellular substance. Every part of the body is surrounded and penetrated by cellular substance, and many of the densest parts are composed of it entirely. The membranes, for example, are nothing but condensed cellular substance, the plates of which are closer than elsewhere, and more exactly applied over one another; and, by maceration, they are resolvable into the common loose cellular texture. Vessels are membranes formed into cylindrical tubes; and, all the soft parts of the body, except the fibres, are an assemblage of vessels, differing in the

the fluids which they convey, in their number, in their courſe, and in the thickneſs of their coats.

The chemical analyſis of theſe ſubſtances, ſolid as well as fluid, diſcovers to us a ſmall number of chemical elements, which, combined in different proportions, form the different ſpecies of animal matter. Some earths, ſome ſalts, phoſphorus, carbon, azote, hydrogen, oxigen, ſmall quantities of ſulphur, and of iron, conſtitute, by their various combinations, the different animal compounds, ſuch as gelatin, albumin, fibrin, &c.; and, theſe again, uniting among themſelves, form the different animal ſolids and fluids which we find in nature. But, we are far from poſſeſſing a complete analyſis of animal matter. There are many animal ſubſtances which we cannot procure in a ſeparate ſtate, without firſt altering their nature; and, we have reaſon to believe, that there are elementary ſubſtances in animals which have hitherto eſcaped us altogether.

The general organ of ſenſation is the nervous ſyſtem formed every where of the ſame medullary matter. In every ſpecies of animals, where the preſence of this matter has been detected, it is divided into threads or filaments, which, proceeding from certain central points, are diſtributed throughout the body, and ſerve many important purpoſes, beſides that of affording ſenſations. The centres from which theſe filaments proceed, com-

municate

municate in a more or lefs intimate manner, and there are many of the filaments which feem to have no other ufe but that of forming media of communication.

The nerves, or cords formed by the affemblage of a number of thefe filaments into a common bundle, when touched by any foreign fubftance, affect us with the fenfation of pain; though the contact of thofe parts of the body, to which they are naturally contiguous, excites in them, in the ftate of health, no fort of fenfation.

Particular organs are placed at the extremities of thofe nerves from which we derive our perceptions of the external world, and the conformation of the organ of fenfe is always in admirable adaptation to the particular nature of the object by which the nerve is to be impreffed.

The general organ of motion is the flefhy or mufcular fibre. This fibre contracts itfelf in obedience to the will; but the will exercifes its power only through the medium of the nerves. There are no mufcular fibres without nervous filaments, and the voluntary power over the mufcles ceafes entirely, when the communication of thefe filaments with the reft of the nervous fyftem is intercepted. Several external agents, applied to the mufcles, excite them to contraction,

contraction, and continue to produce this effect after the nerves have been divided, and even after the complete ſeparation of the muſcles from the body. This property of the muſcular fibre has been called its vis inſita, or irritability. It has been diſputed among Phyſiologiſts, whether the irritability of the muſcles, after their ſeparation from the body, depends on the nervous matter which they ſtill contain, and which cannot be ſeparated from them; or, whether in the action of the will itſelf, the nerve is not to be conſidered as a mere ſtimulus, acting on the inherent power of the fibre. The latter was the opinion of Haller, and of his ſchool; but every day ſeems to add farther probability to the doctrine of his opponents.

All the internal parts of the body, which exert any preſſure upon the ſubſtances which they incloſe, have their coats provided with muſcular fibres and nervous filaments: as the arteries, alimentary canal, heart, &c. But the principal diſtribution of the muſcular fibres is in the muſcles. This is the name given to bundles of fleſhy fibres, attached by their extremities to the moveable parts of an animal body. When the fibres ſhorten themſelves, the two points into which the muſcle is inſerted, are brought nearer, and by this ſimple contrivance all the motions of animals are performed, and

their

their bodies tranſported from one place to another.

Animals that have no other mode of progreſſive motion but creeping, have their muſcles inſerted into different points of the ſkin, which they contract and dilate alternately; but animals, that move forward with greater ſpeed, by diſtinct ſteps or leaps, have their muſcles attached to certain hard parts, ſituated either externally or internally, which ſerve as levers, and move upon one another by centres of motion, called the joints or articulations.

The hard parts, when taken together, are called the ſkeleton; when covered by the muſcles, they are called the bones; when external to the muſcles, they get the names of ſhell, cruſt, ſcales, &c. according to their different degrees of hardneſs. In all caſes, the hard parts ſurround and protect the proper viſcera, and give form and proportion to the body.

The joints are provided with muſcles for performing the motions for which they are adapted, every muſcle pulling the bone to which it is attached in its own particular direction. The muſcles may be conſidered as ſo many moving forces; and their ſtrength, the diſtance of their inſertion from the centre of motion, the length of the lever to which they are attached, and the weight connected with it, determine the duration and velocity of the motions which they produce. Upon these different circumstances depend, in the different species of animals, the force of their leap, the extent of their flight, the rapidity of their course, and their address in catching their prey; but, it is still to be remembered, that the whole of this apparatus would remain without motion, if not animated by the nervous system.

The white and soft medullary substance, which constitutes the essential part of the nervous system, is divided into a vast number of small threads or filaments. These filaments are tied together in bundles or fasciculi, forming the nerves; the gradual union of the nerves into one large fasciculus, is called the spinal marrow. At one extremity of the spinal marrow is placed the brain, that is, a mass of medullary matter, which varies much in size and form, in the different classes of animals.

We are not conscious of the impression of external objects upon our body, unless there be a free communication of nerves between the place where the impression is made and the brain. The ligature or division of the nerve, by intercepting the physical communication, intercepts also the sensation.

There

There is but one ſenſe, which belongs to every claſs of animals, and which is exerciſed over every part of the ſurface of the body; the ſenſe of touch. Its ſeat is in the extremities of the nerves diſtributed over the ſkin, and the ſame organ informs us of the reſiſtance of bodies and of their temperature. The other ſenſes would ſeem to be only more refined modifications of the ſenſe of touch, and ſuſceptible of more delicate impreſſions. Every one knows, that theſe ſenſes are the ſight, ſeated in the eye; the hearing, ſeated in the ear; the ſmell, ſeated in the internal membrane of the noſe; and the taſte, ſeated in the tongue. Theſe ſenſes are very univerſally placed at that extremity of the body, which contains the brain, and is called the head.

The light, the vibrations of the air, the odorous effluvia floating in the atmoſphere, ſaline particles or particles ſoluble in water or ſaliva, are the ſubſtances which act upon theſe four ſenſes, and the organs, which tranſmit their action to the nerves, are admirably appropriated to the reſpective nature of each. The eye preſents to the light a ſucceſſion of tranſparent lenſes, to refract its rays; the ear oppoſes to the air, membranes and fluids, fitted to tranſmit its vibrations; the noſtrils, while they afford a paſſage to the air, in its way to the lungs, intercept any odorous particles which it contains;

tains; and the tongue is provided with ſpongy papillæ, for imbibing the ſapid liquors, which are the objects of taſte.

It is by theſe organs, that we are acquainted with what paſſes around us; but, the nervous ſyſtem gives us notice alſo of many changes, that take place within our own body. Internal pains warn us of the preſence of diſeaſe; and the diſagreeable ſenſations of hunger, thirſt, and fatigue, are ſigns of the body ſtanding in need of refreſhment or repoſe. It is alſo by means of the nervous ſyſtem, that we experience deſire, fear, pity, and the other emotions and paſſions of the mind; but theſe are rather the effects of the re-action of the nervous ſyſtem, than of immediate impreſſions on it from without. They are at the ſame time entirely independent of the will, and yet excite a variety of muſcular motions in different parts of the body. Many effects of the nervous ſyſtem depend on the numerous communications, which particular nerves, called Sympathetic, eſtabliſh between the remoter branches of the general trunk of the nervous ſyſtem, and through which impreſſions are tranſmitted with greater rapidity than by the brain. Thoſe collections of nervous fibriles, which are called Ganglia, are a kind of ſecondary brain, and are obſerved to be larger and more numerous, in proportion as the principal brain is leſs.

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The faculties of ſenſation and of muſcular motion, which, in the greater number of animals, are excluſively confined to the nervous and muſcular fibres, ſeem to be univerſally diffuſed through the whole ſubſtance of ſome gelatinous animals, in whom neither nerve nor muſcular fibre can be diſcovered.

It is by means of theſe two faculties that animals feel, deſire, and are enabled to ſatisfy their wants. The moſt irreſiſtable of theſe is hunger, which reminds them of the neceſſity of providing nutriment for their ſubſiſtence. The function of nutrition begins in the mouth, where the aliments are taken into the body, and where ſolids are broken down and moiſtened with ſaliva. From the mouth the food paſſes into the alimentary canal, which varies much in different animals in its length, width, and convolutions, and is ſurrounded by a number of coats, ſome of which are continued from and reſemble the external teguments of the body.

The coats of the alimentary canal act mechanically upon the food by their power of muſcular contraction, and act chemically by the liquors which they ſecrete.

The principal dilatation of the alimentary canal is called the ſtomach, and, in ſome ſpecies of of animals, there are more ſtomachs than one. The remaining part of the paſſages has the name of inteſtinal canal. From the internal coat of the ſtomach a ſecretion is poured out, which reduces the food to a homogeneous pulpy maſs; and, in the inteſtines, beſides the ſecretions which their own coats afford, there are liquors added to the food, which are ſeparated from the common maſs of blood by particular organs, and conveyed into the inteſtinal canal by appropriate ducts. The moſt important, and the moſt univerſal of theſe organs are the liver and the pancreas. The firſt eſpecially, which forms the bile, is of conſiderable ſize; and the bile, beſides its uſes in the inteſtinal canal, conveys certain ſuperabundant principles out of the blood.

In the inteſtinal canal the nutritive part of the aliment is extracted from it. In animals deſtitute of circulation, the nutritive particles paſs by inviſible pores through the coats of the digeſtive organs; but in animals of a more complicated ſtructure, they are conveyed into the general circulatory maſs, by a particular ſet of very delicate veſſels. Theſe veſſels are the Abſorbents, which, in man, and in the animals reſembling him, are very diſtinct from the ſanguiferous veſſels, but approach gradually nearer to them in the inferior claſſes, and cannot be at all diſtinguiſhed from them in the white blooded animals. Neither the abſorbents nor ſanguiferous

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veins poſſeſs muſcular fibres viſible to the eye; and both are provided with valves which allow their contents to paſs in one direction only, that is, towards the heart. The arteries, on the contrary, are ſtrong and muſcular, but unprovided with valves, the violent impelling force of the heart being ſufficient, without the aid of valves, to impreſs upon the arterial blood, motion in an uniform direction.

But, the chyle or liquid produced by digeſtion, is not ſufficient to renovate the venous blood, and reſtore to it the faculty of nouriſhing the body; the contact of air is neceſſary, before the blood can be returned with ſafety into the arterial ſyſtem. This it is the buſineſs of reſpiration to effect. Where animals have a vaſcular ſyſtem, the organ of reſpiration conſiſts of a minute ramification of blood veſſels, by which the ſurface is prodigiouſly multiplied, and every particle of blood is brought almoſt into contact with the ſurrounding element, nothing being interpoſed between them, except a thin membrane, which is inſufficient to prevent their reciprocal action. In aquatic animals, this ramification of blood veſſels is ſpread over the ſurface of certain thin laminæ, called *Gills* or *Branchiæ:* in animals that live in the air, a ſimilar ramification of veſſels ſurrounds a number of ſmall cells which form the *Lungs*. Where there is no vaſcular ſyſtem, the air penetrates into every part of of the animal, and acts upon the nutritive fluid at the inſtant when it is expended in the nouriſhment of the body. This is the caſe with inſects that have *tracheæ*. In every variety of reſpiration, it is obvious, that muſcular organs are required, to introduce and expell the air, and direct it to the place where the blood is prepared to receive its action. This is the office of the intercoſtals, diaphragm, and abdominal muſcles in Man; of the opercula of the gills in fiſhes; and of various other parts in the different claſſes of animals.

In animals which have cellular lungs and breathe through a long and narrow tube, the formation of the voice is a ſubordinate uſe of reſpiration. For this purpoſe there are looſe membranes ſtretched acroſs a narrow part of the air tube, and the vibrations produced by the current of the air, form what is called the voice. Animals that have no voice, properly ſo called, are neverthelеſs, in many caſes, able to produce ſound; but this is effected by a mechaniſm of a totally different kind from that which forms the true voice.

The blood in its paſſage through the organ of reſpiration, experiences a ſpecies of combuſtion, which abſtracts from it part of its carbon in the form of carbonic acid, and by that means increaſes the proportion of its remaining elements.

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The air is, at the ſame time, deprived of part of its oxigen, which is the only elaſtic fluid that can ſupport reſpiration. The correſponding effects upon the blood are not yet fully underſtood. In animals with red blood, the colour of the blood is enlivened by reſpiration, and it acquires the power of exciting the action of the heart. There is reaſon even to believe, that it is through the action of the air upon the blood, that the muſcular ſyſtem derives its power of contraction. There are other means, beſides reſpiration, of carrying off from the blood ſome of its component parts: many different ſubſtances are ſeparated from it by the kidneys, which ſecrete the urine, and which are preſent in all red-blooded animals; while other ſubſtances are diſcharged by perſpiration, and along with the excrementitious part of the aliment. Theſe three emunctories of the body ſerve, to a certain extent, as ſubſtitutes for one another, and appear to have ſo far a common tendency.

Such is the collection of organs that conſtitute an animal, and which would ſuffice for its individual exiſtence, without any reference to the propagation of its ſpecies. Such, at leaſt, are the organs poſſeſſed by animals of the higher claſſes; for, the whole of theſe organs are far from being reunited in every ſpecies of animals. As we deſcend in the ſcale of Being, they diſappear in ſucceſſion, and at length, in the loweſt and moſt imperfect animals, we find nothing more than what is essential to the idea of animal life, a sentient self-moving sack, capable of digesting food.

When we inquire minutely into the action of these organs, we perceive that all the changes within animal bodies are effected by the combinations and decompositions of the fluids which they contain. The animal function by which one fluid is separated from another, or formed by the mixture and combination of elements derived partly from the one fluid, and partly from the other, is called *Secretion.* This appellation has, indeed, been usually confined to changes which take place in glands, that is, in bodies of various sizes, within which the blood vessels are minutely subdivided, and where, besides their usual terminations in the veins, they terminate in excretory ducts that convey the secreted liquor out of the gland. But, the animal economy presents us with a vast number of other mutations or separations of fluids which have an equal claim to the name of secretion. It is, indeed, hardly possible to conceive, that the nerves can excite the muscles to action, or external objects excite the organs of sense, without some chemical change, in the matter of which these parts are formed; and whatever be the nature of that substance on which the powers of the nervous system depend, it must be separated from the blood by the brain, or rather

by

by every part of the medullary organ. The blood itſelf is not perfectly elaborated till it has been purified from ſome of its principles in the lungs, the kidney, and the liver; and till it has received additional matter from the aliment; nor does the aliment afford chyle, till it has been mixed with various liquors ſecreted from the blood; and the blood nouriſhes the ſolids, through which it circulates only by the particles which are ſeparated from it, while other particles are at the ſame time carried off from the ſolids, to be returned into the common maſs of blood, by the abſorbents.

In a word, all the animal functions are reſolvable into tranſmutations of fluids, and the true ſecret of the animal economy lies hid in the manner in which theſe changes are effected, as health depends on their regularity and order.

In generation, the origin of the germ is concealed from us by its minuteneſs, ſo that we can pronounce nothing with reſpect to the manner of its production; but we find the ſeminal liquor to be a ſecretion, which, in animals that propagate by conjunction of ſexes, is employed to excite the development of the germs; and the ſubſequent progreſs of the embryo, is a proceſs of the ſame kind, and carried on by the ſame means as the ordinary growth of the body.

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The organs of generation, of which we have ſtill to ſpeak, are divided into thoſe which prepare the ſeminal liquor, and apply it to the germ, and into thoſe which contain and protect the germ during the firſt ſtages of its development. The former conſtitute the male, the latter the female ſex.

The teſticles are the glands for the ſecretion of ſemen, and ſeveral other glands prepare liquors to be mixed with it. The ſeminal canal paſſes along the under part of the penis, which ſerves to convey the ſemen into the vagina, or paſſage leading to the uterus or oviduct. The oviduct or Fallopian tube receives the embryo at the inſtant of its ſeparation from the ovarium, and conducts it out of the body, if the animal be oviparous ; or into the uterus, if it be viviparous. The embryo is gradually developed, and draws its nouriſhment, either from the mother, by means of a ſpongy maſs of veſſels connected with the veſſels of the mother, or from an organized maſs called the egg. After it has arrived at the full term, it is forcibly expelled by the uterus, or it burſts the ſhell within which it had been ſhut up.

CHAPTER III.

View of the Principal Differences among Animals, in their Syſtems of Organs.

IT appears, from the preceding chapter, that what is common, in any ſyſtem of organs, to all the claſſes of animals, is reducible to very little; and, that organs ſubſervient to the ſame function, have often no other reſemblance, than in their general effect. This is particularly the caſe with the function of reſpiration, which, in the different claſſes of animals, is exerciſed by organs, that, in ſtructure, have abſolutely nothing in common. The inveſtigation of the differences in the ſtructure of organs ſubſervient to the ſame purpoſe, forms the proper object of comparative Anatomy; and the following rapid ſketch of theſe differences may be conſidered as an outline of that ſcience. We ſhall, therefore, reſume the conſideration of the different animal functions, and examine with what degree of energy they are exerciſed, and in what manner carried on by different animals.

The organs ſubſervient to motion preſent us, in the firſt place, with two great and leading differences

differences, in their relative ſituations. The bones either form an internal, articulated ſkeleton, covered by the muſcles; or, the muſcles are placed internally, and ſurrounded by ſcales, or ſhells. There is ſtill a third claſs of animals who are unprovided with hard parts, to ſerve as a lever or fulcrum for motion.

Animals of the firſt kind, have the body ſupported along its middle part, by a column formed of diſtinct pieces of bone, piled over one another, and called the ſpine of the back or vertebral column. The animals *with vertebræ* conſiſt of four claſſes, the *Mammalia*, *Birds*, *Reptiles*, and *Fiſhes*.

Of the animals *without vertebræ*, the *ſoft worms*, are entirely deſtitute of hard parts; the *inſects* have the body and limbs inveloped in ſcales, articulated together; and, laſtly, the *Teſtacea* are incloſed within ſhells.

It is from the greater or leſs development of particular parts upon this general outline, that the different ſpecies of animals belonging to theſe claſſes are qualified to perform different kinds of motion.

In the organs of ſenſation, we meet with various important differences, ſome of which relate to the internal part of the nervous ſyſtem, and others to the external ſenſes.

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The differences in the internal part of the nervous ſyſtem, preſent us with three well marked diviſions: the firſt of which comprehends animals, in whom neither veſſels nor nerves have been diſcovered, forming the claſs of *Zoophytes* or *Polypi*; the ſecond, conſiſts of animals in whom the brain is placed above the alimentary canal, while the remaining part of the common medullary cord is placed beneath it, and, in the ſame cavity with the viſcera, forming the claſſes of *Molluſcæ*, *Cruſtacea*, *Inſects*, and including part of the *articulated worms*; the third diviſion conſiſting of animals, in whom the common medullary cord is placed above the alimentary tube, towards the back, and incloſed within a canal formed by the vertebral column, conſtitute the claſs of animals with vertebræ. The nervous ganglia in this laſt claſs of animals, are either placed upon the ſides of the ſpinal marrow, or ſcattered in the great cavities; in the Molluſcæ the ganglia are ſeated no where but in the great cavities; in inſects, and in ſome of the articulated worms, they are placed along, and appear to be enlargements of the common medullary cord.

The differences in the external ſenſes relate either to their number, or to their goodneſs.

All the animals with vertebræ, have the ſame number of ſenſes with man.

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The ſenſe of ſight is wanting in the Zoophytes, in many of the articulated worms, in many of the larvæ of inſects, and in the acephalous Molluſcæ. The organ of hearing has been diſcovered in a few only of the Molluſcæ, and in ſome of the inſects. The three remaining ſenſes, but particularly the ſenſes of touch and taſte, ſeem to be preſent in every ſpecies of animals.

But, every one of the ſenſes may differ much in its goodneſs, and in the greater or leſs complication of parts by which it is exerciſed. The perfection of the ſenſe of touch, for example, depends on the delicacy of the external teguments, and on the diviſions of the extremities of the body, which are more particularly employed in the exerciſe of touch; for, the more numerous theſe diviſions are, the more accurately will the organ of touch be applied around external bodies. The number, and mobility of the fingers, and the ſmallneſs of the nails, form, in this reſpect, important characters for the Naturaliſt.

The eyes may be more or leſs mobile, more or leſs protected from external injury, more or leſs numerous. The ears may be ſunk deep within the cranium, or placed more externally, or even provided with a kind of trumpet for collecting the ſonorus undulations of air. The membrane of ſmell may be more or leſs extenſive ; the ſeat of taſte more or leſs tender and moiſt ; but, details on theſe ſubjects would lead to the hiſtory of particular ſenſes.

The organs of digeſtion preſent us in their general arrangement, with two remarkable differences. In the greater part of the Zoophytes, the inteſtines form a bag, which has but one opening, ſerving at once to admit the food, and to diſcharge the excrement. But, all other animals have two diſtinct openings for theſe purpoſes, placed at the two extremities of the alimentary canal, and ſituated at a greater or ſmaller diſtance from one another, according to the convolutions of that canal. Another difference in the organs of digeſtion, which has great influence on the kind of aliment adapted to them, conſiſts in ſome animals having the mouth provided with teeth, or with ſome other hard part, for breaking down ſolid food ; while other animals are totally unprovided with ſuch inſtruments, and muſt either ſwallow entire bodies if the mouth be large enough, or, ſuck up liquids if the mouth be in the form of a tube. The form of the teeth has great influence on the nature of the food which animals are able to maſticate ; and the remaining part of the alimentary canal, has its conformation, in ſome meaſure, regulated by the food which it receives from the mouth : Hence, the more or leſs conſiderable length of the inteſtinal canal, the greater or ſmaller number

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of ſtomachs, of inteſtina cæca, and many other details foreign to the preſent view of the ſubject.

The chyle, formed by the action of the digeſtive organs upon the aliment, is tranſmitted to the reſt of the body, in two different ways. It either paſſes through inviſible pores in the coats of the inteſtinal canal, and tranſudes through every part of the body; or it is taken up by abſorbent veſſels, and carried into the general maſs of blood. It paſſes by tranſudation in the Zoophytes; and alſo, according to Cuvier, in the inſects, which appear to him to have no veſſels appropriated for the circulation of the nutritive fluid. * Among the animals which have abſorbents, there are two farther differences to be obſerved. The animals with vertebræ have the blood red, and the chyle white or tranſparent; while the greater part by far of the Molluſcæ have the blood and chyle of the ſame colour. The animals with vertebræ differ with reſpect to the colour of the chyle. Among the claſs Mammalia, it is of an opake white; in birds, reptiles, and fiſhes, it is tranſparent, like lymph. The chyliferous veſſels alſo, in the three laſt claſſes, have no conglobate glands connected with them, while theſe glands are very numerous in the claſs Mammalia.

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* See a Memoir on this ſubject by Cuvier in the Journal de Phyſique T. XLIX.

In the organs employed for the circulation of the blood, there are very important differences. In the firſt place, there are animals which have no circulation, as the *Inſects* and the *Zoophytes*; and in the ſecond place, where the circulation exiſts, it is either ſingle or double. The double circulation is that wherein no part of the venous blood can return into the arterial ſyſtem, till it has made a complete circuit through the organ of reſpiration; which is in that caſe formed by the expanſion of two large veſſels, the one arterial, and the other venous, both nearly as large, though not ſo long, as the large vein and artery of the body. This is the circulation in Man, in the *Mammalia*, in *Birds*, in *Fiſhes*, and in many of the *Molluſcae*.

The circulation is ſingle, when a great part of the venous blood returns into the arterial ſyſtem, without paſſing through the lungs, that organ being an expanſion of a branch only of the principal artery. This is the circulation of *reptiles*.

Other differences exiſt in the number and poſition of the Hearts, or muſcular organs employed to give an impulſe to the blood. Where the circulation is ſingle, there is but one heart; but where the circulation is double, there is ſometimes one heart at the baſe of the pulmonary artery, and another heart at the baſe of the principal artery; while in other caſes there is but one heart for both circulations.

Where there are two hearts or rather two ventricles, theſe either form a ſingle maſs, as in Man, in the Mammalia and in Birds; or they are ſeparated and placed at ſome diſtance as in the genus *Sepia*.

Where there is but one ventricle, it is either placed at the root of the principal artery of the body, as in *Snails*, and other molluſcæ; or at the root of the pulmonary artery, as in Fiſhes.

The organs of reſpiration are not leſs fruitful in important differences. Where the air is employed to act directly upon the blood, it is introduced into the interior of the organ of reſpiration; but, where it acts through the medium of water, the water paſſes merely over the ſurface of that organ; and the laminæ by which the ſurface is multiplied, are called the *gills* or *branchiae*. There are gills in fiſhes and in many of the molluſcæ; but in place of laminæ, the organ of reſpiration ſometimes conſiſts of looſe fringes.

The air penetrates into the interior of the body, either by one opening, or by more openings than one. The firſt is the caſe with all animals,

animals, that have lungs, properly ſo called; and the tube which admits the air, is afterwards divided into a number of branches, that terminate in as many ſmall cells, which are commonly united together into two ſeparate maſſes, dilatable and compreſſible at the pleaſure of the animal.

When there are more openings than one, which is the caſe only with inſects, the veſſels that admit the air, ſpread by innumerable ramifications, through every part of the body. This is called reſpiration by means of *Tracheæ*.

Laſtly, none of the Zoophytes, except the Echinus, Aſterias, and other genera belonging to the ſame order, have any viſible organs of reſpiration.

The organs of voice offer but two general differences, depending on the ſituation of the glottis, or part where the ſound is formed. In birds, the glottis is placed at the bottom of the trachea or air tube, where it divides into two principal branches, one for each of the lungs. In quadrupeds and reptiles, the glottis is ſituated at the top of the trachea, and at the root of the tongue.

Theſe three are the only claſſes of animals which are provided with a glottis; but there

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are other animals which can produce ſound, though by a mechaniſm of a different kind. Some employ for that purpoſe the friction of certain elaſtic parts; others employ the vibrations of certain parts in the air; while others impreſs a rapid motion on portions of air incloſed within ſome part of their body.

Generation preſents us with two ſpecies of differences; one with regard to the mechaniſm by which it is effected, and the other with regard to its produce.

In a ſmall number of animals, of which the whole belong to the claſs of Zoophytes, generation takes place without copulation, the young animal growing from the body of the adult, like a bud upon a tree. Other animals propagate their ſpecies by copulation only, and are conſequently provided with the organs of two ſexes. Theſe are either placed in two ſeparate individuals, or placed together in the ſame individual. The latter diſtribution is found among the Molluſcæ and Zoophytes; inſects and all animals with vertebræ, have the two ſexes in two ſeparate individuals.

Some hermaphrodite animals, ſuch as the bivalve Teſtacea, have no occaſion for the conjunction of two individuals, in order to produce offspring; whereas this is eſſentially neceſſary in in Snails and other ſpecies of molluſcæ, that creep upon the belly, among whom each individual performs at one and the ſame time, the function of both male and female.

The offspring of generation is preſented to us in three different forms. It is either a bud, projecting from the parent, and growing from it like the branch of a tree, till completely developed; or, it is a fœtus, which arrives at maturity in the uterus of its mother, where it is attached by veſſels, and from which it comes out alive; or, it is an embryo, ſhut up within a ſhell, along with a ſubſtance connected to it by veſſels, and which it converts into nouriſhment, before it is completely hatched. From theſe varieties, animals are ſaid to be *gemmiparous*, *viviparous*, or *oviparous*. The Gemmiparous claſs are confined to a few Zoophytes and articulated worms. The Viviparous claſs includes Man and the other Mammalia. All other animals are Oviparous. In the Viper, the young come alive out of the mother, but it is becauſe the eggs are hatched within the oviducts.

In the laſt place, when we attend to the changes of form, through which the young animal is obliged to paſs, before it is fit to propagate its ſpecies, we find them reducible to two principal heads. Some animals have at birth

birth the ſame form which they afterwards retain, with the exception of a ſmall number of inconſiderable parts, not fully developed, or which have not yet acquired their due proportion to the reſt of the body.

Other animals are quite different in form at birth, from what they are in their perfect ſtate, and have therefore not only to produce and develope new parts after birth, but muſt loſe many of their original parts. Theſe changes are called the *metamorphoſes* of animals. They have been hitherto obſerved only among inſects, and among reptiles without ſcales, that is in *Frogs* and *Salamanders*.

Such are the principal varieties in the organs appropriated to the different animal functions.

There is ſtill indeed a very important difference to be remarked, which extends its influence over a great number of functions. It relates to the organs of ſecretion. In the four claſſes of animals with vertebræ, the organs of ſecretion are glands, or at leaſt minute ramifications of blood veſſels, the term Gland being ſtrictly applicable to bodies only of a particular form and ſtructure.

But this is not the caſe with inſects, who have no other organs of ſecretion except tubes of of different lengths, which attract into the ſpongy texture of their coats, thoſe particles that are to be ſeparated from the general maſs of the nutritive fluids.

Separate organs of ſecretion have not yet been diſcovered in the claſs of Zoophytes.

CHAP. IV.

View of the Relations that ſubſiſt between Variations in the Different Systems of Organs.

SOME of the principal differences in the ſtructure and action of the organs, which are appropriated to each of the animal functions, have been conſidered in the laſt chapter. A more minute examination of the ſubject would enable us to add conſiderably to the number of differences which was there ſtated; but from the enumeration already made, it may be conceived what a vaſt number of combinations might be formed, correſponding to as many claſſes of animals, by uniting each ſeparate modification of each particular organ, with all the modifications of the other organs in ſucceſſion.

But many of theſe combinations, which in the abſtract appear not impoſſible, cannot exiſt in nature, becauſe the organs of a living body are not related, by their juxta poſition merely in the ſame ſubject, but alſo by their reciprocal action upon one another, and by their concurrence in producing a common effect. In conſequence of this mutual influence of the different organs, the modifications of any one organ af-

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fect the modifications of every other organ. Such of these modifications as cannot co-exist in the same individual, may be regarded as mutually exclusive; while there are other modifications that reciprocally imply, as it were, each others existence. These observations will be found applicable, not only to organs which are directly and obviously related, but even to those which appear, at first sight, to be the most remote and the least connected.

In fact, there is not a single function, which does not require the assistance and co-operation of all the other functions, and which is not affected by the degree of energy with which the other functions are exercised.

Respiration, for example, cannot be carried on, without the motion of the blood; for the office of respiration is to bring every particle of the blood into contact with the air or the water that surrounds the animal body; and, therefore, since it is the circulation which gives motion to the blood, the circulation becomes a necessary step towards respiration.

The circulation itself depends on the muscular action of the heart and arteries, and therefore cannot be carried on without the aid of muscular irritability. This faculty again would remain inert, without the nervous system, which brings us back to the circulation of the blood, the ſource of every ſecretion, and conſequently of the matter compoſing the nerves.

How limited would have been the faculty of ſenſation, if it had not been aided by the muſcular power? Of what uſe would have been the ſenſe of touch, if the hand could not have been employed for the examination of external bodies? How confined would have been the perceptions of viſion, if we had poſſeſſed no power of turning the head, or of moving the eyes?

Upon this mutual dependance of the functions, upon this reciprocal aid which they receive and which they beſtow, depends a ſyſtem of laws, which regulate the relations of living organs, and which are themſelves founded on the ſame neceſſary relations as the laws of metaphyſics or of mathematics; for it is ſelf evident, that a ſuitable harmony among organs, which are to act upon one another, is a neceſſary condition for the exiſtence of the Being to which they belong, and that if one of its functions were modified in a manner incompatible with the modifications of the other functions, that Being could not exiſt.

We ſhall take a curſory view of ſome of the more important of theſe relations, and for that

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purpofe compare together, two by two, the different functions of animals.

To begin with one of the moft obvious of thefe relations, it is manifeft, that the mode of refpiration in different animals, muft vary with the manner in which the motion of the nutritive fluid is carried on. In animals where there is a heart and vafcular fyftem, the nutritive fluid is continually collecting in a central refervoir, from which it is projected with force to every part of the body. It is paffing continually from the heart to the extreme veffels, and returning from the extremities to the heart. It is poffible, then, to expofe the whole nutritive fluid to the air, at the very fource of its motion in the heart; and, accordingly, in thefe animals, before the nutritive fluid is conveyed by the arteries to the diftant parts of the body for nutrition, it is circulated through the lungs or gills, where it receives the action of the air. But, a difference of ftructure in the organs of refpiration becomes neceffary in animals, which, like the infect tribe, have neither heart nor blood-veffels. As the nutritive fluid of thefe animals has no regular motion, and proceeds not from any common fource; but tranfudes, like dew, through the coats of the alimentary canal, and, diffufing itfelf throughout the body, fupplies every part with nourifhment; it is impoffible to prepare it

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for nutrition, in a ſeparate organ, before its general diſtribution through the body, The action of the air muſt therefore be exercifed, at the place and at the inſtant of the intus-ſuſception of nutritive particles; and this is completely effected in theſe animals by the arrangement of the tracheæ or air veſſels, the minute ramifications of which are diſtributed through every part of the body, and ſupply air wherever its chemical action is wanted.

Since we perceive diſtinctly in theſe inſtances the cauſes of the relations which we find ſubſiſting between the organs of circulation and thoſe of reſpiration, we are authoriſed to preſume, that other correſpondences in ſtructure which we find equally conſtant, are equally neceſſary, though we ſhould be unable to trace the connection. Thus, among animals having blood veſſels and a double circulation, thoſe which reſpire air directly, by receiving it into the lungs, are obſerved to have always the trunks of the two principal arteries placed cloſe to one another, and provided with two fleſhy ventricles, united into a ſingle maſs; whereas animals that breathe by the intervention of water, which they compreſs between the laminæ of the gills, have always the trunks of the two principal arteries ſeparated, and placed at ſome diſtance; and this is obſerved to be the caſe, whether each of the principal arterial trunks be provided

provided with a ſeparate ventricle, as in the genus Sepia; or, whether one of them only be furniſhed with a ventricle, as in the reſt of the Molluſca and in Fiſhes.

We perceive more clearly the nature of thoſe relations which connect together the extent and mode of reſpiration in different animals, with their locomotive faculties; and which render air ſo much the more neceſſary to animals, in proportion as their modes of life enable them to procure it in the greateſt abundance. In other words, the animals which can get pure air with the greateſt facility, are preciſely the animals which are in the greateſt dependance on reſpiration.

Modern experiments have ſhown, that one of the principal uſes of reſpiration, is to reanimate the muſcular power, by recruiting the exhauſted irritability of the muſcular fibre. We accordingly obſerve, that, among animals which reſpire air directly, thoſe poſſeſſed of a double circulation, and in whom no particle of venous blood can return to the ſolids, till it has paſſed through the organ of reſpiration, (the claſs of Birds and the claſs of Mammalia,) not only live continually in the air, and perform muſcular motions of far greater ſtrength than other red-blooded animals; but, likewiſe, that each of theſe claſſes enjoys the muſcular power preciſely in that degree which

correſponds

correfponds to its refpiration. Birds live continually in the air, and are as completely immerfed in it within the body, as they are without; for, not only is the cellular part of the lungs, in Birds, very large, but there are air-bags or appendages to the lungs, diffufed through every part of the body. Birds, accordingly, confume, in proportion to their fize, a greater quantity of air, in a given time, than Quadrupeds; and, it is this undoubtedly, which gives to the mufcular fibre of Birds, that prodigious and rapid force of contraction, which fits it to be the moving power in machines, that muft be fupported in the air by the mere vibrations of wings.

In the force of mufcular motion, and in the quantity of air confumed by refpiration, the clafs of Mammalia hold a middle place between Birds and Reptiles, two claffes of animals, which may be juftly oppofed to one another. Refpiration appears, in the clafs of Reptiles, to be a fubordinate or acceffory function only. Reptiles can exift without refpiration as long very nearly as they pleafe. Their pulmonary veffels are branches only of the great arterial trunk. Accordingly, while upon the one hand, their organs of motion oblige them to remain upon the ground, in obfcure and ftifled places, and in the midft of miafmata; and while their inftinct leads them to fhut themfelves up in caverns, where the air is never renewed, or to immerfe themfelves under water

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for a great part of the year; on the other hand, their motions are very generally ſlow and languid, and they paſs the greater part of their exiſtence in a ſtate of nearly abſolute repoſe.

Farther, as it is one of the conditions eſſential to the exiſtence of every animal, that its phyſical wants be not greater than its means of ſatisfying them, ſo it is obſerved in the claſs of Reptiles, that in proportion as the reſpiration is leſs prompt, and leſs efficacious to recruit the irritable power, ſo much the leſs eaſily is the irritability exhauſted. It is from this cauſe that the muſcles of Reptiles are ſo tenacious of irritability, and palpitate ſo long after their ſeparation from the body, while the muſcles of warm-blooded animals loſe their irritability as they cool.

This relation between the energy of the muſcular power and the degree of action in the ſurrounding element, is confirmed by the example of Fiſhes, who having, like Reptiles, the blood cold, have alſo, like them, very little muſcular power, and an irritability not ſpeedily exhauſted. In judging of the muſcular power of Fiſhes, we muſt not allow ourſelves to be deceived by the velocity with which ſome of theſe animals are known to ſwim; for being placed in an element of the ſame ſpecific gravity with themſelves, they are ſupported in it without any exertion of their own.

But, if the refpiration of Fifhes be productive of the fame confequence as the refpiration of Reptiles, the effect is obtained by different means. As it is only the fmall quantity of air diffolved in water, which has accefs to the blood in Fifhes, it becomes neceffary that the inconfiderable effect produced by a fingle circulation through the gills, fhould be compenfated by the quick return of the blood, and therefore the circulation of Fifhes is double, like that of warm-blooded animals. We difcover, in this inftance, a new relation between the modifications of the organs of refpiration and the organs of circulation. Animals, to whatever clafs they belong, if they refpire by gills and through the medium of water, have a double circulation; whereas, among animals who refpire air, there are many who have the circulation fingle, that is, all animals who require not a great degree of mufcular power. But, as the combination is no where to be found, of a fingle circulation with refpiration by gills, it may be concluded, that this combination would reduce too low the efficacy of refpiration, and render it unfit to fupport the mufcular power.

The relations of the nervous fyftem to the refpiration appear from the varieties in each which are obferved to correfpond. The external fenfes are much lefs energetic, and the brain is of much inferior magnitude, in cold-blooded animals, where it occupies only a part of the cavity

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of the cranium, than it is in warm-blooded animals, where it fills the whole of that cavity. The inconfiderable degree of mufcular power which can be exerted by the mufcular fibre in cold-blooded animals is, perhaps, the reafon why fo little active power is given to the organ which excites it to contraction. Lively fenfations and violent paffions, would have too powerfully exhaufted the irritability of the mufcles. By this circuitous channel, then, the modifications of the organs of fenfe are connected with the modifications of the organs of refpiration.

But, from what fecret caufe does it proceed, that in all animals, who refpire by a particular organ, the maffes of medullary matter are few in number, and collected within the cranium, or at leaft diftinct from the fpinal marrow; whereas, in animals that breathe by tracheæ, there are numerous ganglia, of nearly equal fizes, arranged at fmall diftances along the whole length of that cord? And why, in the ftructure of animals, who have no organ particularly appropriated for refpiration, is there no appearance of a nervous fyftem to be traced? Both thefe relations are ftill inexplicable.

Digeftion is another function, not without its relations to refpiration. For, refpiration being the function, which confumes and carries off with the greateft rapidity, the fubftance of which the body is compofed, the digeftive organs re-

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quire to be more powerful in proportion as the reſpiration is more active, in order that the quantity of matter introduced into the body may be equal to the quantity of matter evacuated from it.

It is through the medium of theſe connections between the modifications of the organs of reſpiration, and thoſe of the organs of the other functions, that ſome of the latter acquire relations to one another, which are not otherwiſe eaſily explicable. Birds have, in general, a very powerful ſtomach, and a very quick digeſtion. Birds make very frequent meals; while reptiles, who, in every particular, appear, of red-blooded animals, to be the Antipodes of Birds, aſtoniſh us by the ſmall quantity of aliment which they conſume, and by the length of the faſts which they endure. It is not ſo much through the organs of motion, in theſe two claſſes of animals, that theſe differences in the organs of digeſtion are rendered neceſſary, as through the organs of reſpiration, the modifications of which, again, have a direct relation to thoſe of the organs of motion.

It is evident, that theſe two very different degrees of digeſtive force muſt depend on two equally diſtinct diſpoſitions in the organs of digeſtion, and that neither of them could co-exiſt in the ſame individual, but with its correſpond-

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ing diſpoſition in the organ of reſpiration. The organ of reſpiration, again, being connected by relations equally conſtant with the organs of motion, the organs of ſenſation, and the organs of circulation, it follows, that all the five ſyſtems of organs are governed and directed by each ſyſtem in particular.

But, beſides this indirect connection, the ſyſtem of digeſtive organs has direct relations to the organs of motion and of ſenſation; for, the ſtructure and diſpoſition of the digeſtive organs neceſſarily determines the kind of aliment proper for every ſpecies of animals; and, it is obvious, that if the ſenſes and organs of motion in any ſpecies of animals be inſufficient to diſtinguiſh, and procure for them their proper aliment, that ſpecies of animals cannot ſubſiſt.

Thus, animals who can digeſt nothing but fleſh, muſt, under the penalty of inevitable deſtruction, be able to diſcern their prey at a diſtance, to purſue it, to catch it, to get the better of it, to tear it in pieces. They muſt, therefore, poſſeſs a piercing eye, an acute ſenſe of ſmell, ſwiftneſs in purſuit, addreſs and force in the organs for catching their prey. Accordingly, a canine tooth, adapted to tear fleſh, was never found, in the ſame animal, along with a hoof, fit for ſupporting the weight of the body, but totally unqualified for laying hold of prey. Hence, the rule that every hoofed animal is herbivorous, and

and as corollaries from this general principle, the maxims that a hoofed foot indicates grinding teeth with flat ſurfaces, a long alimentary canal, a large ſtomach, and often more ſtomachs than one, with many other ſimilar conſequences.

The laws, which regulate the relations between different ſyſtems of organs, have the ſame influence on the different parts of the ſame ſyſtem, and connect together its different modifications, by the ſame neceſſary principles. In the alimentary ſyſtem eſpecially, where the parts are large and numerous, theſe rules have their moſt ſtriking applications. The form of the teeth, the length, the convolutions, the dilatations of the alimentary canal, the number and abundance of the gaſtric liquors, are in the moſt exact adaptation to one another, and have ſimilar fixed relations to the chemical compoſition, to the ſolid aggregation, and to the ſolubility of the aliment; in ſo much that from ſeeing one of theſe parts by itſelf, an experienced obſerver could form concluſions tolerably accurate, with reſpect to the conformation of the other parts of the ſame ſyſtem, and might even hazard more than random conjectures with reſpect to the organs of other functions.

The ſame harmony ſubſiſts among the different parts of the ſyſtem of organs of motion. As all the parts of this ſyſtem act mutually, and are acted upon, eſpecially when the whole body

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of the animal is in motion, the forms of all the different parts are ſtrictly related. There is hardly a bone that can vary in its ſurfaces, in its curvatures, in its protuberances, without correſponding variations in other bones; and in this way, a ſkilful Naturaliſt, from the appearance of a ſingle bone, will be often able to conclude, to a certain extent, with reſpect to the form of the whole ſkeleton to which it belonged.

Theſe laws of co-exiſtence, which have juſt been indicated, are deduced by reaſoning from our knowledge of the reciprocal influence of the functions, and of the uſes of the different organs of the body. Having confirmed them by obſervation, we are enabled, in other circumſtances, to follow a contrary route; and when we diſcover conſtant relations of form between particular organs, we may ſafely conclude, that they exerciſe ſome action upon one another; and we may thus be frequently led to form juſt conjectures with reſpect to their uſes. For example, the remarkable ſize of the liver in animals, where the reſpiration is inconſiderable, and the total abſence of that viſcus in inſects, where the reſpiration is the moſt complete that can be imagined, ſince every part of the body is a kind of pulmonary organ, have given riſe to the conjecture, that the liver performs, to a certain extent, the ſame office with the

the lungs, by carrying off from the blood ſome part of its combuſtible elements.

Guided by the ſame ſpirit of analogy, we ſhould be led to explain the whiteneſs and opacity of the chyle, in particular animals, while in the greater part it is tranſparent, when we are told that the animals in whom the chyle is white, are thoſe animals preciſely that have breaſts, and ſecrete milk for the nouriſhment of their young. It is, indeed, chiefly from the attentive ſtudy of theſe relations, and from the diſcovery of relations which have hitherto eſcaped our notice, that Phyſiology has reaſon to hope for the extenſion of her limits; and accordingly the comparative anatomy of animals is one of the moſt fruitful ſources to her of valuable diſcovery.

In the laſt place, Nature, while confining herſelf ſtrictly within thoſe limits which the conditions neceſſary for exiſtence preſcribed to her, has yielded to her ſpontaneous fecundity wherever theſe conditions did not limit her operations; and without ever paſſing beyond the ſmall number of combinations, that can be realiſed in the eſſential modifications of the important organs, ſhe ſeems to have given full ſcope to her fancy, in filling up the ſubordinate parts. With reſpect to theſe, it is not inquired, whether an individual form, whether a particu-

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lar arrangement, be neceſſary; it ſeems often not to have been aſked, whether it be even uſeful, in order to reduce it to practice: it is ſufficient, that it be poſſible, that it deſtroy not the harmony of the whole. Accordingly, as we recede from the principal organs, and approach to thoſe of leſs importance, the varieties in ſtructure and appearance become more numerous; and when we arrive at the ſurface of the body, where the parts the leaſt eſſential, and whoſe injuries are the leaſt momentous, are neceſſarily placed, the number of varieties is ſo great, that the conjoined labours of Naturaliſts have not yet been able to give us an adequate idea of them.

In the number of theſe combinations, there are neceſſarily many which have parts in common, and there are always ſome which differ but little, ſo that by placing in ſucceſſion thoſe which have the greateſt reſemblance, it is poſſible to conſtruct a kind of ſeries or ſcale, that ſhall appear to recede gradually from a primitive model. It is this view of the ſubject, which has ſuggeſted to certain Naturaliſts the idea of the ſcale of Being; by which is meant, that all Beings may be placed in a ſeries or ſcale, beginning with the moſt perfect, and terminating in the moſt ſimple, or in the one which poſſeſſes qualities the leaſt numerous and moſt common, ſo that the mind in paſſing along the ſcale, from one Being to another, ſhall be nowhere confcious of any chafm or interval, but proceed by gradations almoft infenfible. In reality, while we confine our attention within certain limits, and efpecially while we confider the organs feparately, and trace them through animals of the fame clafs only, we find them proceed, in their degradation, in the moft uniform and regular manner, and often perceive a part, or veftige of a part, in animals where it is of no ufe, and where it feems to have been left by Nature, only that fhe might not tranfgrefs her general law of continuity.

But, on the one hand, all the organs do not follow the fame order in their degradation. *This* organ is at its higheft ftate of perfection in one fpecies of animals; *that* organ is moft perfect in a different fpecies; fo that, if the fpecies are to be arranged after each particular organ, there muft be as many fcales or feries formed, as there are regulating organs affumed; and in order to conftruct a general fcale of perfection, applicable to all Beings, there muft be calculation made of the effect refulting from each particular combination of organs—a calculation which it is needlefs to add, is hardly practicable.

On the other hand, thefe flight fhades of difference, thefe infenfible gradations continue to be obferved, only while we confine ourfelves to the

fame

ſame combinations of leading organs, only while we direct our attention to the ſame great central ſprings. Within theſe boundaries all animals appear to be formed on one common plan, which ſerves as the groundwork to all the leſſer internal modifications: but the inſtant we paſs to animals, where the leading combinations are different, the whole of the reſemblance ceaſes at once, and we cannot but be conſcious of the abruptneſs of the tranſition.

Whatever ſeparate arrangements may be ſuitable for the two great claſſes of animals, with and without vertebræ, it will be impoſſible to place at the end of the one ſeries, and at the commencement of the other, two animals ſufficiently reſembling to form a proper bond of connection.

CHAP.

CHAPTER V.

Claſſification of Animals from their internal Organization.

ANIMALS may be divided into the two great families of animals with vertebræ and red blood, and of animals without vertebræ, and moſt of them with white blood.

The former have always an internal articulated ſkeleton, of which the chief connecting part is the vertebral column. The anterior part of this column ſupports the head; the canal which paſſes from one end of it to the other, incloſes the common faſciculus of the nerves; its poſterior extremity is moſt frequently prolonged, in order to form the tail; and its ſides are articulated with the ribs, which are ſeldom wanting. None of this family of animals has more than four limbs, ſome of them have two only, and others have none.

The brain is always incloſed in a particular oſſeous cavity of the head, called the cranium. All the nerves of the ſpine contribute filaments to form a nervous cord, which has its origin in the

the nerves of the cranium, and is diſtributed to the greater part of the viſcera.

The ſenſes are always five in number. There are always two eyes, moveable at pleaſure. The ear has always at leaſt three ſemicircular canals. The ſenſe of ſmell is always confined to particular cavities in the fore part of the head.

The circulation is always performed by one fleſhy ventricle at leaſt; and where the ventricles are two in number, they are always cloſe together, forming a ſingle maſs. The abſorbent veſſels are diſtinct from the ſanguiferous veins.

The two jaws are always placed horizontally, and open from above downwards. The inteſtinal canal is continued without interruption, from the mouth to the anus, which is always placed behind the pelvis, that is, behind the circle of bones, which affords a fixed point for the poſterior extremities. The inteſtines are inveloped within a membranous ſac, termed peritonæum. There is always a liver and a pancreas, which pour their ſecretions into the cavity of the inteſtines; and there is always a ſpleen, within which part of the blood undergoes ſome preparatory change, before it is ſent to the liver.

There

There are always two kidneys for the ſecretion of urine, placed on the two ſides of the ſpine, and without the peritonæum. The teſticles alſo are always two in number. There are always two bodies, called atrabiliary capſules, placed over the kidneys; the uſe of them is unknown.

Animals with vertebræ are ſubdivided into two branches, one of which is warm-blooded, and the other cold-blooded.

Vertebrated animals with warm blood, have always two ventricles, and a double circulation. They reſpire by means of lungs, and cannot exiſt without reſpiration. The brain fills exactly the cavity of the cranium. The eyes are covered with eye-lids. The tympanum of the ear is ſunk within the cranium; the different parts of the labyrinth are completely incloſed within bone; and, beſides the ſemicircular canals, the labyrinth contains the cochlea with two *ſcalæ*, reſembling the ſhell of the ſnail. The noſtrils always communicate with the throat, and afford a paſſage for the air of reſpiration. The trunk is furniſhed with ribs, and almoſt all the ſpécies of this branch of animals have four limbs.

Vertebrated animals with cold blood, reſemble one another more by their negative, than by their poſitive characters. Many of them are deſtitute

deſtitute of ribs; ſome of them are totally deſtitute of limbs. The brain does not fill the whole cavity of the cranium. The eyes ſeldom have moveable eye-lids. The tympanum of the ear, when preſent, is always cloſe to the ſurface of the head; it is often wanting, as are likewiſe the oſſicula auditus; the cochlea is always wanting. The different parts of the ear are not firmly attached to the cranium; they are often looſely connected with it, and in the ſame cavity with the brain.

Each of theſe two branches is ſubdivided into two claſſes.

The two claſſes of warm-blooded animals are the *Mammalia* and *Birds*.

The *Mammalia* are viviparous, and ſuckle their young with milk ſecreted by the mammæ. The females have conſequently always the cavity termed Uterus, with two cornua; and the males have always a penis *intrans*.

The head is ſupported on the firſt vertebra by two eminences. The vertebræ of the neck are never leſs than ſix, nor more than nine. The brain has a more complicated ſtructure than in other animals, and contains many parts which

are

are not to be found in the other claſſes, ſuch as the corpus calloſum, fornix, pons, etc.

The eyes have two eye-lids only. The ear contains four ſmall bones, articulated together, and has a ſpiral cochlea. The tongue is quite ſoft and fleſhy. The ſkin is covered entirely with hairs, in the greater number, and in all, it is covered partially.

The lungs fill the cavity of the cheſt, which ſeparated from the abdomen by a fleſhy diaphragm. There is one larynx only, ſituated at the baſis of the tongue, and completely covered by the epiglottis, when the animal ſwallows.

The lower jaw only is moveable. Both jaws are covered with lips.

The biliary and pancreatic ducts are inſerted into the inteſtinal canal at the ſame place. The lacteal veſſels convey a white milky chyle, and paſs through a number of conglobate glands, ſituated in the meſentery. A membrane called omentum, ſuſpended from the ſtomach and adjacent viſcera, covers the fore part of the inteſtines. The ſpleen is always upon the left ſide, between the ſtomach, ribs, and diaphragm.

Birds are oviparous. They have only one ovarium, and one oviduct, in which they differ from

from other oviparous animals. The head is ſupported on the firſt vertebra of the neck by a ſingle eminence. The vertebræ of the neck are very numerous, and the ſternum very large. The anterior extremities are uſed for flying, and the poſterior for walking.

The eyes have three eye-lids. There is no external ear; the tympanum contains only one bone; and the cochlea is a cone ſlightly curved. The tongue has a bone internally. The body is covered with feathers. The lungs are attached to the ribs. The air paſſes through the lungs, in its way to the air bags, which are diſperſed throughout the body. There is no diaphragm. The trachea has a larynx at each end, and the upper one has no epiglottis. The mouth conſiſts of a horny bill without lips, teeth or gums, and both mandibles are moveable.

The pancreas and liver ſend out ſeveral excretory ducts, which enter the inteſtines at different places. The chyle is tranſparent, and there are no meſenteric glands, nor omentum. The ſpleen is in the center of the meſentery. The ureters terminate in a cavity called the cloaca, which alſo affords an exit to the ſolid excrement, and to the eggs. There is no urinary bladder.

The two claffes of cold-blooded animals are the *Reptiles* and *Fifhes*.

The *Reptiles* differ from one another in many very effential particulars, and have not fo many characters in common as the other claffes. Some of the Reptiles walk, fome fly, fome fwim, many can only creep. The organs of the fenfes, and particularly the ear, differ almoft as much as the organs of motion; none of the Reptiles, however, have a cochlea. The fkin is either naked, or covered with fcales. The brain is always very fmall. The lungs are in the fame cavity with the other vifcera; there are no air-bags beyond the lungs; but, the cells of the lungs are very large. There is but one larynx, and no epiglottis. Both the jaws are moveable. There are neither mefenteric glands, nor omentum. The fpleen is in the center of the mefentery. The female has always two ovaria, and two oviducts. There is a bladder. *

Fifhes refpire by means of organs, in the fhape of combs, placed at the two fides of the neck, between which they force water to pafs. They have, confequently, neither trachea, larynx, nor voice. The body is formed for fwimming. The fins

* The clafs of *Reptiles* in the arrangement of Cuvier, correfpond to the orders of *Reptiles pedati*, and *Serpentes apodes*, belonging to the clafs of *Amphibia*, in the Syftema Naturæ of Linnæus.

fins are ſometimes wanting: beſides the four, which correſpond to the limbs, they have vertical fins upon the back, under the tail, and at its extremity.

The noſtrils are not employed in reſpiration. The ear is quite hid within the cranium. The ſkin is naked, or covered with ſcales. The tongue is oſſeous. Both jaws are moveable. There are often cæca in place of the pancreas. There is a bladder, and two ovaria. *

The animals deſtitute of vertebræ have leſs in common, and form a leſs regular ſeries than the vertebrated animals. But, when they have hard parts, theſe are generally placed on the outſide of the body, at leaſt when articulated; and the nervous ſyſtem has not its middle part incloſed within a canal of bone, but looſely ſituated in the ſame cavity with the other viſcera.

The brain is the only part of the nervous ſyſtem which is placed above the alimentary canal. It ſends out two branches, which encircle the oeſophagus, like a necklace, and which afterwards unite and form the common faſciculus of the nerves.

None

* The claſs of *Fiſhes* include the *Fiſhes* and the *Amphibia Nantes* of Linnæus.

None of the animals without vertebræ reſpire by cellular lungs, and none of them have a voice. Their jaws are placed in all kinds of directions, and many of them have only organs of ſuction. None of them have kidneys, or ſecrete urine. Thoſe among them which have articulated members, have always ſix at leaſt.

Conſidered anatomically, theſe animals may be diſtributed into five claſſes.

The *Molluſca* form the firſt claſs.

The body of the Molluſca is fleſhy, ſoft, and without articulated members, though ſometimes containing hard parts internally, and ſometimes covered completely by hard ſhells. They have arterial and venous veſſels, within which the blood undergoes a true circulation.

They reſpire by branchiæ. The Brain is a diſtinct maſs, from which the nerves and medulla oblongata proceed. There are ganglia in different parts of the body.

The internal ſenſes vary as to their number. Some of the Molluſca have the organs of ſight and hearing quite diſtinct, while others ſeem to be confined to the ſenſes of touch and taſte. Many of them can maſticate their food ; others have the power of ſwallowing only.

They

They have a very large liver, which affords a great quantity of Bile. The organs of generation vary extremely.*

The *Cruſtacea* form the ſecond claſs.

The body is covered with a hard cruſt, in ſeparate pieces. There are articulated limbs, which are often very numerous. The nervous ſyſtem conſiſts of a long, knotted cord, from the ganglia of which proceed all the nerves.

The eyes are compound, hard, moveable. The Ears are very imperfect. For the ſenſe of touch, the Cruſtacea have antennæ and palpi, like inſects. They have a heart, arterial and venous veſſels, and branchiæ for reſpiration. The jaws are tranſverſe, strong and numerous. The ſtomach has teeth within. The numerous cæca afford a brown liquor, which ſeems to be in the place of Bile. The penis is double, and there are two ovaria. †

The *Inſects* form the third claſs.

In

*The claſs of *Molluſca* comprehend the greater part of the animals, whom Linnæus has arranged in the two orders of *Molluſca* and *Teſtacea*, in the claſs of *Vermes*; ſuch as the *Sepia*, *Limax*, *Aſcidia*, *Helix*, *Oſtrea*, *Patella*, *Pholas*, *Teredo*, etc.

† The *Cruſtacea* include the genus *Cancer* and the genus *Monoculus* of Linnæus.

In their perfect ſtate they have, like the Cruſtacea, articulated limbs and antennæ. Moſt of them have alſo membranous wings, which enable them to fly. All theſe laſt paſs through ſeveral metamorphoſes, in one of which they are quite deſtitute of the power of motion. All of them have a nervous ſyſtem ſimilar to that of the Cruſtacea; but inſects have neither heart nor blood veſſels, and reſpire by tracheæ. Not only the liver, but all the ſecreting organs are wanting, and their place is ſupplied by long veſſels, which float looſely in the abdomen. The form of the inteſtinal canal is often very different in the ſame individual, in its three different ſtates.*

The animals which reſemble the larvæ of inſects, and have, like them, the medullary cord knotted, may be placed in the ſame claſs with inſects, though they undergo no metamorphoſis; but there are ſome of that number, which have diſtinct ſanguiferous veſſels, and which muſt be arranged in a ſeparate claſs, intermediate between

* The claſs of *Inſects* correſponds to the ſame claſs in the Syſtema Naturæ, with the exception of the two genera ſeparated from it, in order to form the claſs of Cruſtacea.

tween the Mollufca, Cruftacea, and Infects. To this clafs belong *Earth worms* and *Leeches*. *

This being the fourth clafs, the *Zoophytes* will form the fifth.

The Zoophytes have the parts of their body placed in a ftar-like form, proceeding like the radii of a circle from the center, where the mouth is placed. They have neither heart, nor veffels ; nor has there been difcovered in them a nervous fyftem. †

* The clafs of *Worms* comprehends fome of the genera, arranged by Linnæus among the *Vermes Inteftina*, fuch as the *Lumbricus*, *Gordius*, *Hirudo* ; fome of the genera placed by the fame Naturalift among the *Vermes Mollufca* fuch as the *Aphrodita*, *Nereis*, *Terebella* ; and laftly fome genera included in his order of *Vermes Teftacea*, fuch as the *Serpula*, *Dentalium*.

† The clafs of *Zoophytes* correfpond to the *Zoophyta* and *Lithophyta* of Linnæus ; but alfo include fome of the Vermes Mollufca, fuch as the *Echinus*, *Afterias*, *Holothuria*, *Actinia*, *Medufa*, together with the genus *Sipunculus* from the Vermes Inteftina.

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CORRIGENDA.

p. l.

3 12 *for* had been, *read* was.

7 2 — they are afterwards to devolope, *read* are to be afterwards developed.

9 7 — of a different kind, *read* regulated by laws essentially different.

8 — renew the attempt, *read* engage anew in the investigation.

11 9 — these, *read* the.

24 26 — the, *read* these.

25 18 — all, *read* both.

32 16 — loose, *read* tense.

47 20 — includes, *read* include.

Throughout the 3d chap. for Molluscæ, read Mollusca.

To Mr Geo: Bell

With best respects from

the Author

Edinburgh 12th Augst 1801